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Combat Vehicle (CV) Accidents in Field Training Exercises (FTXs)

A. L. Franklin
J. C. Lavender
D. A. Seaver

April 1991

Prepared for
the U.S. Army Safety Center
Ft. Rucker, Alabama
under a Related Services Agreement
with the U.S. Department of Energy
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1.0 INTRODUCTION

The U.S. Army Safety Center (USASC) has undertaken a comprehensive program of technical studies to develop effective procedures for reducing accidents/injuries and improving accident prevention. Included in this effort is an in-depth analysis of combat vehicle (CV) accident occurring during field training exercises (FTXs) Army CVs are defined as tactical tracked vehicles such as tanks, armored personnel carriers, and self-propelled artillery.

Successful accident prevention programs depend upon comprehensive accident reporting procedures. These procedures are specified in Army Regulation, AR 385-40, which requires that an accident report (DA Form 285) be submitted to higher command authority and the USASC by the unit responsible for the vehicle involved and/or the personnel injured. This report provides data required by the Department of Defense, Department of Labor, and the Army for statistical and accident prevention purposes. Each year, certain accidents are subject to in-depth investigation by Army installation safety office personnel. Investigation findings and suggested remedial measures are recorded on DA Form 285-1. The in-depth investigation is designed to identify the causal factors and system inadequacies which caused or contributed to the accident. Submission of the approved DA Forms 285 and 285-1 to the USASC completes the accident reporting process.

DA Form 285-1 is required for four categories of accidents:

1. Fatal injuries to on-duty Army personnel
2. Fatal injuries to non-Army personnel as a result of Army operations
3. Special categories of serious accidents
4. Random sampling of all serious on-duty accidents.

Included in this report are the results of an analysis of FTX combat vehicle accident reports submitted on DA Form 285-1 in compliance with the criteria for the special category during a recent targeted year. Also analyzed were all FTX combat vehicle (more serious and less serious) accidents during a five-year period which includes the targeted year.

The purpose of this study is threefold:

1. To analyze the in-depth information reported on the DA Form 285-1's during the targeted year;
2. To identify major problem areas and system inadequacies for the accidents analyzed; and
3. To recommend courses of action for reducing the number of CV FTX accidents.

2.0 METHODOLOGY

The analysis methodology for investigation of combat vehicle accidents during field training exercises is intended to identify systemic problems that lead to such accidents. It is based on the "3W" approach to accident investigation and prevention developed by the U. S. Army Safety Center :

- What happened? - categorized into human error, materiel failure, and environmental factors
- What caused it? - identified by the basic Army system inadequacy causing the accident
- What to do about it? - specified remedial measures targeted at specific command levels

The primary data for this investigation were specifically collected to address the systemic causes for this type of accident. For a targeted calendar year, these accidents were identified for in-depth investigation and reporting using the DA Form 285-1. Individual investigations were conducted by trained safety professionals, thus providing information more directly focused on systemic accident causes than the more general data contained in the DA Form 285, the form on which all accidents are reported. For the purposes of this data collection, a DA Form 285-1 was required if the accident met one or both of the following criteria:

- 1) the most seriously injured on-duty government person, military or civilian, lost 20 or more workdays, or sustained a more serious injury; or
- 2) damage to Army property was $700 or more.

Reports were received on 83 of these accidents.

Each narrative provided in the DA Form 285-1's was examined by an analyst experienced in evaluation of narrative accident data. The analysts evaluated the circumstances of the accident in order to identify problem areas (i.e., characteristics of the accident that can be highlighted as hazardous or that require special awareness on the part of the vehicle operator/maintainer). The problem areas used were those previously identified by Sisk, Throckmorton, and Ricketson (1983) using factor analysis. The analysts making these judgments used these problem areas only after they were satisfied that problem areas in the current data were well-captured by those previously identified.

Once problem areas were identified, the analysts examined the 285-1 reports to identify the system inadequacies for each accident, that is, the deficient elements of the Army safety system that led to the accident. For example, the problem area "improper ground guiding" was found to be the result of "inadequate self-discipline" in several of the accidents. Thus, the self-discipline of the individual involved in the accident was the point at which

the Army safety system was inadequate to prevent the accident in question. Different accidents, identified as belonging to the same problem area, often resulted from different system inadequacies. The analysis summarized the system inadequacies within each problem area, and looked for patterns in the relationship between system inadequacies and problem areas.

Based upon the problem area findings discussed above, projections were made of the impacts of each of these problem areas for a one-year and a five-year period. Numbers of accidents, injuries, fatalities, and costs were projected for each problem area by first determining the relative number of accidents in the sample of DA Form 285-1 data collected for the study, in the total accident data base for the single year, and in the total data base for five years. For example, there were 1915 CV accidents in FTX's over the five-year period, and 160 for the one-year period. The accidents reported in the 285-1's thus represented 51.9 percent of the one-year accidents and 4.3 percent of the five-year accidents.

This percentage was then used to calculate expected numbers of accidents, injuries, fatalities, and costs. For example, the problem area "improper ground guiding" included nine accidents. These nine accidents were assumed to represent 51.9 percent of the accidents associated with this problem area during the one-year period (projecting a one-year total of 17 accidents), and 4.3 percent of the five-year accidents in this problem area (projecting a five-year total of 208 accidents).

In order to project injuries, fatalities, and costs, the reciprocal of the above percentages (representing the ratio of the number of accidents in the two data pools) was multiplied by the number of injuries, number of fatalities, or the dollar costs. For example, the injury cost of the 285-1 data in the "improper ground guiding" problem area was $238,445. This figure was multiplied by the reciprocal of 51.9 percent (i.e., approximately 1.928) to result in an estimated $459,653 in injury costs for the one-year period.

3.0 FINDINGS

For the selected five-year period, the total number of CV accidents during FTXs was 1,915. As a result of these accidents, 1,677 Army personnel were injured and 66 killed. The total cost of these accidents was $25,701,156, with $16,281,291 in damages to government property and $9,419,865 in personnel injury costs (see Table 1). A review of accidents for the targeted year reveals that 40 percent of accidents, 97 percent of damage costs, 81 percent of injury costs, and 92% of total cost occurred in the serious accident classification. (NOTE: One M1 accident in the target year resulted in damages of $2.8M. This is 71 percent of the entire damage cost for the target year. In fact, it is greater than the total damage cost for all serious accidents in three of the remaining four years of the study.)

A total of 153 personnel were involved in the cases with DA Form 285-1 (83) in the targeted year. Of these, 138 had entries for hours of continuous duty prior to the accident. The average was 13.1 hours, and the median was 10.0. Fifty-three (64%) of the 83 cases involved personnel who continuous duty prior to the accident exceeded 8 hours. Ninety of the 138 personnel exceeded 8 hours of duty at the time of the accident. Among these same 153 personnel, 84 had entries for hours of sleep in the 24 hours prior to the accident. The median was 6.4 hours. Fifty-six of the 84 reported less than 8 hours of sleep.

Of the 83 accidents with in-depth reports, 53 percent occurred between 0600 and 1759 hours; 30.1 percent occurred between 1800 and 2359 hours, and only 16.9 percent occurred between 2400 and 0559 hours.

The largest number of these serious accidents with in-depth investigations occurred in May (15.7%), October (15.7%), March (12%), August (9.6%), February (9.6%), and July (9.6%). The other six months accounted for the remaining 27.7 percent.

TABLE 1. Five-Year Summary of CV FTX Accidents

Year	Accidents	Damage Cost	Injury Cost	Total Cost	Military Injuries Fatal	Non-Fatal
1	350	$ 2,753,579	$1,410,555	$ 4,164,134	15	278
2	313	2,776,894	1,839,675	4,616,569	13	304
3	398	4,317,162	2,167,800	6,484,962	17	357
4	424	2,255,898	2,178,630	4,434,528	9	363
5	430	4,177,758	1,823,205	6,000,963	12	375
TOTAL	1,915	$16,281,291	$9,419,865	$25,701,156	66	1,677

In regards to collisions, 80.7 percent of the accidents occurred on-post and 19.3 percent off-post; 36.1 percent of this same group of accidents were classified as other types of collisions; 20.5 percent involved other vehicles; 18.1 percent involved running off the road; 9.6 percent involved pedestrians; 8.4 percent were collisions with objects. Six percent of the accidents were identified as backing collisions; 1.2 percent were classified as overturned.

The nine problem areas from Sisk Throckmorton and Ricketson (1983) were determined to capture all 83 of the 285-1 accidents. Table 2 provides data on the number of accidents and accident costs by problem area. Inadequate inspection/testing was the most frequent problem area (22.8 percent), and had the highest damage, total, and average cost. Excessive speed for conditions had the highest injury cost.

A total of 171 system inadequacies was identified in the 83 serious accidents. More than one system inadequacy can be identified for an accident. The system inadequacies generating each major problem area are summarized in Table 3. One system inadequacy, inadequate self-discipline encompasses: (1) inadequate composure, (2) inadequate attention, (3) overconfidence in self/others/equipment, (4) lack of confidence, (5) inadequate motivation/haste/pressure/attitude, and (6) efforts of alcohol/drugs/illness.

TABLE 2. Frequency and Costs of Serious CV FTX Accidents in Targeted Year with DA Form 285-1

Major Problem Areas	N	%	Damage Cost	Injury Cost	Total Cost	Average Cost
Inadequate Inspection/ Testing	19	22.9	$2,990,787	$194,915	$3,185,702	$167,669
Rough Terrain	12	14.5	458,313	81,115	539,428	44,952
Excessive Speed for Conditions	11	13.2	300,060	472,555	772,615	70,238
Darkness	9	10.9	155,933	272,525	428,458	47,606
Improper Ground Guiding	9	10.9	7,068	238,455	245,513	27,279
Inadequate Coordination/ Communication	9	10.9	339	143,455	143,794	15,977
Narrow Congested Roads	6	7.2	22,006	51,400	73,406	12,234
Following Too Closely	5	6.0	19,501	3,560	23,061	4,612
Improper Passing	3	3.6	2,494	5,100	7,594	2,531
TOTAL	83	100.0	$3,956,501	$1,463,070	$5,419,571	$65,296

TABLE 3. System Inadequacies Related to Major Problem Areas

PROBLEM AREA / SYSTEM INADEQUACY	Inadequate Self-Discipline	Inadequate Supv. by Direct Supervisor	Inadequate Unit Training	Inadequate Experience	Environmental Conditions	Inadequate Written Proc. (Normal Ops.)	Fatigue	Inadequate Maintenance	Eqmt/Mat'l Improperly Designed/Not Provided	Improper Use of Tool/Eqmt.	Inadequate School Training	Inadequate Facilities/Services	Inadequate Coord. By Higher Command	Inadequate Written Proc., Abnormal Ops.	Habit Interference	Inadequate Coord. by Staff Officer	Insufficient Info
Inadequate Inspection/Testing	9	4	1	1	2	1	2	6							1		3
Rough Terrain	7	1	1	3	3					1		1					1
Excessive Speed for Conditions	13	3	5	2	2	3	2	1		1							2
Darkness	5	1	1	2	2	3	2		2			2				1	2
Improper Ground Guiding	10	3	1	1	1	2	3		2	2			1	1			3
Inadequate Coordination/Communication	9	2	3	2	2	2		1	1								
Narrow Congested Road	4	3	2	1						1							1
Following Too Closely	4		1	1	1		1										2
Improper Passing	2		1	2	1												
TOTAL	63	17	16	15	14	11	10	8	5	3	2	2	2	1	1	1	14
Percent (excluding Insufficient Information)	36.8	9.9	9.4	8.8	8.2	6.4	5.8	4.7	2.9	1.8	1.2	1.2	1.2	0.6	0.6	0.6	

The following sections describe the nine problem areas and the DA Form 285-1 data in each problem area. Each section begins with a summary of the accident statistics for that problem area from the DA Form 285-1 sample, and estimates for the total accident statistics for the target year and the five-year period. The percentages given for system inadequacies are computed without those labeled "insufficient information."

3.1 INADEQUATE INSPECTION/TESTING

Description: Inadequate inspection/testing and mechanical defect/failure make up this major problem area, to which 229 of the accidents were attributed, making it the most frequent problem area. Tank/Track Commanders and drivers failed to fully inspect their tracks, steering gear, brakes, as well as turret and hatches prior to operation; or did so improperly.

	From Sample (N=83)	Estimate Serious Accidents in Target Year (N=160)	Estimate for All Accidents During Five Year (N=1,915)
Accidents	19	37	438
Damage Cost	$2,990,787	$3,837,662	$69,006,401
Injuries	13	25	300
Fatalities	3	6	69
Injury Cost	$194,915	375,740	$4,497,135
Total Cost	$3,185,702	$4,213,402	$73,503,536
Average Total Cost	$167,669		

Hazards:

a. Loose bolts, worn locking mechanisms, broken or chipped sprockets all become unsafe when the operating crew of a tracked vehicle fails to identify and correct these deficiencies prior to engaging in a tactical movement or when the vehicle is taken from a maintenance area.

b. Improper positioning during inspection/testing exposes personnel to injury hazard, particularly during track maintenance.

System Inadequacies:

a. Inadequate Self-Discipline (33%)

Example: Because of inadequate attention during PMCS, SM failed to discover the worn locking mechanism on the torsion bar of the overhead hatch on a combat recovery vehicle. As the vehicle lurched forward, the hatch slammed on his thumb. The worn mechanism was not discovered during scheduled maintenance (Log Number: S4004).

b. Inadequate Maintenance (22%)

Example: The TC allowed an M60A1 tank with know defective brakes to be parked on an incline. It rolled forward and crushed the driver who was standing in front of the tank after dismounting. The TC was influenced by time pressures to operate the tank rather than deadline it. The tank had air in its hydraulic brake system that had not been purged following a power pack replacement by a contractor (Log Number: 40581).

c. Inadequate Supervision by a Direct Supervisor (15%)

Example: A SM failed to secure the loaders hatch and it fell on his head during travel on a rough trail.

d. The Remaining System Inadequacies Spanned Six Other Categories

(1) Environmental Conditions (7%)
(2) Fatigue (7%)
(3) Inadequate Unit Training (4%)
(4) Inadequate Experience (4%)
(5) Inadequate Written Procedures, Normal Conditions (4%)
(6) Habit Interference (4%).

3.2 ROUGH TERRAIN

Description: FTXs are planned and executed to approach battlefield conditions which involve cross-country movement over rough terrain. CV crews and passengers are trained to be properly positioned to hold on to appropriate hand-holds, and to wear seat belts or restraints when available. This major problem area represented the second highest cost for materiel damage, $458,313.

Personnel involved in accidents associated with rough terrain failed to follow procedures for traversing cross-country (as indicated above), misjudged the speed of their CV in accommodating to rough terrain. They also failed to conduct an adequate search or behind their vehicle for any hazard.

	From Sample (N=83)	Estimate Serious Accidents in Target Year (N=160)	Estimate for All Accidents During Five Year (N=1,915)
Accidents	12	23	277
Damage Cost	$458,313	$883,495	$10,574,329
Injuries	10	19	230
Fatalities	0	2	0
Injury Cost	$ 81,115	$156,366	$1,871,509
Total Cost	$539,428	$1,039,861	$12,495,837
Average Total Cost	$ 54,952		

Hazards:

a. Traversing rough terrain, particularly at higher than prudent CV speeds, often results in injuries caused by passengers being thrown about inside the vehicle and hatch covers closing unexpectedly.

b. The pressures of an FTX, with the resulting fatigue of men and materiel, lead to increased CV mishaps due to crew disregard of the terrain.

System Inadequacies:

a. Inadequate Self-Discipline (40%)

Example: In his haste, the TC failed to inspect the area to his rear prior to ordering the M1 driver to reverse direction. As a result, the tank struck a ditch, and the TC was thrown against the hatch and suffered a fractured jaw (Log Number: S4039).

b. Inadequate Experience (18%)

Example: The SM failed to hold onto a restraint in a moving APC because of his lack of experience. As the vehicle was traversing rough terrain, he was thrown against the inside of the vehicle and suffered a cracked vertebra (Log Number: S4002).

c. Environmental Conditions (18%)

Example: The driver of an M113A2 was watching a ground guide when he struck a stump hidden by weeds. The final drive housing was damaged.

d. The Remaining System Inadequacies Spanned Four Other Categories:

(1) Inadequate Supervision by a Direct Supervisor (6%)
(2) Inadequate Unit Training (6%)
(3) Inadequate School Training (6%)
(4) Inadequate Coordination by Higher Command (6%).

3.3 EXCESSIVE SPEED

Description: Such conditions as slippery surfaces, inclined roadways, and hazardous curves contributed to this major problem area. This major problem area represented the highest cost for personnel injury ($472,555), and the total cost averages $70,238 per accident. It also contributed the most injuries. Personnel involved in these accidents failed to anticipate a hazardous situation and adjust speed for the conditions of the surfaces they were traversing.

	From Sample (N=83)	Estimate Serious Accidents in Target Year (N=160)	Estimate for All Accidents During Five Year (N=1,915)
Accidents	11	21	254
Damage Cost	$300,060	$ 578,429	$6,923,071
Injuries	21	40	485
Fatalities	3	6	69
Injury Cost	$472,555	$ 310,949	$10,902,925
Total Cost	$772,615	$1,489,378	$17,825,996
Average Total Cost	$ 70,238		

Hazards:

a. Excessive speed while negotiating curves and crossing narrow bridges is often a factor in these accidents.

b. CVs are heavy vehicles and are difficult to stop on varying surface conditions, a fact not appreciated by drivers with a lack of experience training, or supervision.

System Inadequacies:

a. Inadequate Self-Discipline (41%)

Example: SM had driven an M42A1 on the same tank trail several times previously without encountering severe washout conditions. As a result of overconfidence, he did not think it was necessary to driver over the same tank trail more slowly at night. When the vehicle passed over a washed out section of the trail, he was thrown about inside and sustained a broken arm and dislocated wrist. There was no damage to the vehicle (Log Number: 40419).

b. Inadequate Unit Training (17%)

Example: Because of a lack of training, an M88A1 driver attempted a 90 degree turn at too great a speed and failed to downshift. The vehicle left the road and overturned. The driver lacked knowledge of the proper driving techniques required to operate the tank recovery vehicle in an emergency situation. The DA Form 285 did not say what the emergency was (Log Number: S4029).

c. The Remaining System Inadequacies Spanned Seven Other Categories:

(1) Inadequate Supervision by a Direct Supervision (9%)
(2) Inadequate Written Procedures, Normal Conditions (9%)
(3) Inadequate Experience (6%)
(4) Environmental Conditions (6%)
(5) Fatigue (6%)
(6) Inadequate Maintenance (3%)
(7) Improper Use of Tools/Equipment (3%).

3.4 DARKNESS

Description: These accidents were caused by failure to follow procedures, orders or laws, e.g., driving in black-out conditions and failing to stop when tank crew could not discern objects ahead clearly. This problem area tied for the highest number of fatalities (4).

	From Sample (N=83)	Estimate Serious Accidents in Target Year (N=160)	Estimate for All Accidents During Five Year (N=1,915)
Accidents	9	17	208
Damage Cost	$155,933	$300,594	$3,597,731
Injuries	4	8	92
Fatalities	4	8	92
Injury Cost	$272,525	$525,349	$6,287,776
Total Cost	$428,458	$825,943	$9,885,507
Average Total Cost	$ 47,606		

Hazards:

a. Darkness is a foreign milieu for many soldiers and becomes a more difficult condition as fatigue increases with the tempo of FTX operations. Consequently, errors in judgment increase and result in men being run over by CVs maneuvering through assembly and bivouac areas.

b. Darkness, precipitation, and thick dust are factors which limit visibility and lead to collisions.

System Inadequacies:

a. Inadequate Self-Discipline (24%)

Example: Neither the TC nor the driver of an M60A3 tank could see well enough to recognize and avoid hazards in the darkness. Since his tank had fallen behind the rest of the formation and he wanted to catch up, the TC did not stop the tank even when it became apparent that they could no longer distinguish terrain differences and hazards. AS a result, none of the crew members recognized that the tank was proceeding across a rock ledge bordering on a steep drop-off. The TC directed the driver to continue the forward movement at a reduced speed. The tank rolled left about three-quarters of a complete rotation and crushed the TC. The sense of urgency contributed to this hasty decision, which was complicated by darkness (Log Number: 40547).

b. Inadequate Written Procedures, Normal Operations (14%)

Example: A range guard on a night firing exercise was run over by an M48 when he failed to use his flashlight to signal his position. He sustained fatal injuries.

c. The Remaining System Inadequacies Spanned Eight Other Categories:

(1) Inadequate Experience (9.5%)
(2) Environmental Conditions (9.5%)
(3) Fatigue (9.5%)
(4) Equipment/Materiel Improperly Designed/Not Provided (9.5%)
(5) Inadequate Facilities/Services (9.5%)
(6) Inadequate Supervision by a Direct Supervisor (4.9%)
(7) Inadequate Unit Training (4.8%)
(8) Inadequate Coordination by a Staff Office (4.8).

3.5 IMPROPER GROUND GUIDING

Description: Tank/Track Commanders sometimes fail to use ground guides at all or to use them properly. Ground guide problems include the mispositioning of guides, misunderstanding of their procedural responsibilities and misinterpretation of signals from and to the ground guides. These errors are compounded by adverse environmental conditions. This major problem area accounted for 10.8 percent of the accidents, and tied for the highest number of fatalities.

	From Sample (N=83)	Estimate Serious Accidents in Target Year (N=160)	Estimate for All Accidents During Five Year (N=1,915)
Accidents	9	17	208
Damage Cost	$ 7,068	$ 13,625	$ 163,075
Injuries	4	8	92
Fatalities	4	8	92
Injury Cost	$238,445	$459,653	$6,501,472
Total Cost	$245,513	$473,653	$6,664,547
Average Total Cost	$ 27,279		

Hazards:

a. Inadequately trained ground guides are a hazard to themselves, CV crews, and other personnel in the immediate area. Their incomplete knowledge of procedures increases the possibility of an accident because TC assume that a ground guide has the skill, training, and experience to do his job. Stumps, ditches, and personnel sleeping alongside, behind, or in front of parked CV constitute real hazards to be identified before moving a tracked vehicle.

System Inadequacies:

a. Inadequate Self-Discipline (37%)

Example: Because of overconfidence and the pressure of the tactical situation, the ground guide inadequately inspected the area between himself and several M113's located about 60 meters away. He positioned himself at a point 30 meters inside the perimeter with an occupied area between himself and the inbound CVs. When he signaled the M113's to proceed, in darkness, the M113 ran over a soldier sleeping on the ground and killed him (Log Number: 40015).

b. Inadequate Supervision by a Direct Supervisor (11%)

Example: The TC of an M60A3 failed to position the ground guide outside the falling range of trees before driving the tank between them. Consequently, the guide was struck by a tree, knocked down by the tank, and suffered a broken ankle (Log Number: 40275).

c. Fatigue (11%)

Example: The SM, suffering from fatigue, improperly decided to lie down in his sleeping bag on the spot where he jumped out of his SPLL. This was an unauthorized sleeping area. The driver drove the SPLL to a POL tanker for refueling, returned the SPLL to the original area, and ran over the SM in his sleeping bag. The driver, who was also fatigued, decided to move the tracked vehicle without a ground guide (Log Number: S4051).

d. The Remaining System Inadequacies Spanned Eight Other Categories

(1) Inadequate Written Procedures, Normal Operations (7%)
(2) Equipment/Materials Improperly Designed/Not Provided (7%)
(3) Improper Use of Tools/Equipment (7%)
(4) Inadequate Unit Training (4%)
(5) Inadequate Experience (4%)
(6) Environmental Conditions (4%)
(7) Inadequate Coordination by a Higher Command (4%)
(8) Inadequate Written Procedures, Abnormal Conditions (4%).

3.6 INADEQUATE COORDINATION/COMMUNICATION

Description: The practiced interaction among members of CV crews is severely strained during an FTX. In the tactical environment, situations for which a training module has not been written often occur spontaneously. The CV crew must successfully cope with each evolving situation as it occurs during FTXs or deployment; 10.9 percent of the accidents were attributed to this major problem area. The most frequent individual errors were: failure to coordinate actions or communicate with crew members and ground guides; failure to recognize impending unsafe conditions requiring greater coordinations.

	From Sample (N=83)	Estimate Serious Accidents in Target Year (N=160)	Estimate for All Accidents During Five Year (N=1,915)
Accidents	9	17	208
Damage Cost	$ 339	$ 653	$ 7,822
Injuries	7	13	162
Fatalities	1	2	23
Injury Cost	$143,455	$276,540	$3,309,835
Total Cost	$143,794	$277,193	$3,317,657
Average Total Cost	$ 15,977		

Hazards:

a. Coordination and communication among CV crew members becomes fragmented under the pressure of FTXs resulting in misinterpreted orders. Turrets and guns slowed without warning cause fractures and crushed body parts.

b. Ground personnel are injured when they do not ensure that drivers are aware of their location.

System Inadequacies:

a. Inadequate self-discipline (41%)

Example: Serviceman (SM) was injured by the main gun tube because of inadequate attention. He did not ensure that he was totally clear of the tube when the Tank/Track Commander (TC) ordered "power." He failed to recognize the TC's warning (Log number: S4032).

b. Inadequate unit training (14%)

Example: An inexperienced loader in an M1 tank reached over the M240 ammunition box to secure loose equipment. His head was crushed when the gunner engaged his palm switches, causing the ammunition box to move upward. Unit training evidently had not provided enough practice in the loader position to preclude miscoordination of actions between the gunner and his loader (Log Number: S4020).

c. The remaining system inadequacies spanned six other categories:

(1) Inadequate Supervision By Direct Supervision (9%)
(2) Inadequate Experience (9%)
(3) Environmental Conditions (9%)
(4) Inadequate Written Procedures, Normal Operations (9%)
(5) Inadequate Maintenance (4.5%)
(6) Equipment/Materiel Improperly Designed Not Provided (4.5%).

3.7 NARROW CONGESTED ROADS

Descriptions: Narrow congested roads, meeting other vehicles, and convoy/road marches are components of this major problem area. Personnel usually misjudged the clearance between their CV and other vehicles, objects, or natural hazards on narrow/congested roads. They also failed to devote the proper attention to the situation facing them.

	From Sample (N=83)	Estimate Serious Accidents in Target Year (N=160)	Estimate for All Accidents During Five Year (N=1,915)
Accidents	6	12	138
Damage Cost	$ 22,006	$ 42,421	$ 507,729
Injuries	4	8	92
Fatalities	2	4	46
Injury Cost	$ 51,400	$ 99,084	$1,185,916
Total Cost	$ 73,406	$141,505	$1,693,645
Average Total Cost	$ 12,234		

Hazards:

a. CVs in convoys or on road marches are likely to meet other vehicles on narrow congested roads, particularly in Europe. Road marches conducted on tank trails during FTXs in the continental United States (CONUS) pose similar hazards because of wide CVs moving in and out of tactical positions on narrow trails. Under these conditions, avoiding unsafe traffic situations is critical and requires alertness and defensive driving skills.

b. Vehicles often fail to maintain proper spacing in convoy and strike the vehicle ahead or lose contact with the convoy during black-out conditions.

System Inadequacies:

a. Inadequate Self-Discipline (37%)

Example: An NCOIC allowed an unlicensed driver to operate an M730. The driver collided with a stopped M113A1 injuring himself and an occupant of the M113A1.

b. Inadequate Supervision by a Direct Supervisor (27%)

Example: A SM made an improper decision to drive a tracked vehicle through a city, and damaged the attachments on top of the vehicle on an overpass.

c. Inadequate Unit Training (18%)

Example: An M113 driver failed to follow procedures outlined in a letter of instruction for vehicle operation during a major FTX and left his disabled vehicle unattended on a tank trail. As a result, it was struck by a tank. The unit had failed to instruct the driver regarding the content of the letter of instruction (Log Number: S4064).

d. The Remaining System Inadequacies Spanned Two Other Categories:

(1) Inadequate Experience (9%)
(2) Inadequate School Training (9%).

3.8 FOLLOWING TOO CLOSELY

Description: This major problem area combines the factors of following too closely and dusty roads/surfaces. Personnel involved in these accidents misjudged the clearance between their CVs and other vehicles and failed to recognize an unsafe rate of closure.

	From Sample (N=83)	Estimate Serious Accidents in Target Year (N=160)	Estimate for All Accidents During Five Year (N=1,915)
Accidents	5	10	115
Damage Cost	$ 19,501	$ 37,592	$ 449,933
Injuries	5	10	115
Fatalities	0	0	0
Injury Cost	$ 3,560	$ 6,863	$ 82,137
Total Cost	$ 23,061	$ 44,455	$ 532,070
Average Total Cost	$ 4,612		

Hazards:

a. Tactical maneuvers involving CVs in conditions of heavy dust concentrations due to the FTX, employment of smoke, low illumination, and blackouts create a dangerous environment.

b. Tactical formations of tracked vehicles in FTXs sometimes feature one or more trailing vehicles which can experience problems of keeping in contact with the rest of the formation.

System Inadequacies:

a. Inadequate Self-Discipline (50%)

Example: An SM driving a M113 was following another M113 too closely and collided with it when it stopped in dusty conditions. The SM was not wearing his seat belt and sustained a leg injury.

b. The Remaining System Inadequacies Spanned Four Other Categories:

(1) Inadequate Unit Training (12.5%)
(2) Inadequate Experience (12.5%)
(3) Environmental Conditions (12.5%)
(4) Fatigue (12.5%).

3.9 IMPROPER PASSING

Description: Improper passing of vehicles, other CVs, and hazards form this major problem area. The primary cause of accidents attributed to this major problem area was misjudging the clearance between the CV and other vehicles.

	From Sample (N=83)	Estimate Serious Accidents in Target Year (N=160)	Estimate for All Accidents During Five Year (N=1,915)
Accidents	3	6	69
Damage Cost	$ 2,494	$ 4,808	$ 57,543
Injuries	1	2	23
Fatalities	0	0	0
Injury Cost	$ 5,100	$ 9,831	$ 117,669
Total Cost	$ 7,594	$ 14,639	$ 175,211
Average Total Cost	$ 2,531		

Hazards:

a. Road traffic mostly in Europe poses a severe hazard for large, bulky combat vehicles which are much slower than other vehicles. Newer tanks passing other CVs on tank trails in low illumination face similar hazards.

b. Convoys are timed evolutions which do not stop for stalled or parked vehicles on roads they are traveling. A passing hazard exists in any circumstance which allows less than 10 meters of clearance.

System Inadequacies:

a. Inadequate Self-Discipline (33%)

Example: An M110 howitzer and an M548 stopped in convoy for repairs. After the howitzer was repaired, the SM tried to reenter the Autobahn without interfering with the fast passing lane of traffic. In his haste, he misjudged the clearance and struck the rear of the M548 (Log Number: S4001). The SM inability to handle the M110 howitzer in traffic and his inattention to both the M548 oncoming automobile traffic contributed to this accident.

b. Inadequate Experience (33%)

Example: An M113A1 driver misjudged the distance between two trees and struck them, injuring himself and damaging the vehicle.

c. Inadequate Unit Training (17%)

Example: In the example in (a) above, lack of unit training contributed to the SM's ability to correctly judge clearance.

d. Environmental Conditions (17%)

Example: In the example in (a) above, darkness contributed to the misjudgment of clearance.

4.0 DISCUSSIONS AND CONCLUSIONS

Other than environmental conditions (8.2%), six system inadequacies accounted for the majority (77.1 percent) of the system problems:

(1) Inadequate Self-Discipline (36.8%)
(2) Inadequate Supervision (9.9%)
(3) Inadequate Unit Training (9.4%)
(4) Inadequate Experience (8.8%)
(5) Inadequate Written Procedures, Normal Conditions (6.4%).
(6) Fatigue (5.8%).

This finding is consistent with other results investigating system inadequacies. For example, Franklin, Lavender, Seaver, and Stillwell (1989) found these same six system inadequacies accounted for 78.4 percent of the accidents involving new tracked vehicles, with inadequate self-discipline the most frequent (38.2 percent). The six predominant system inadequacies are discussed in detail below.

4.1 SYSTEM INADEQUACY: INADEQUATE SELF-DISCIPLINE

Inadequate self-discipline consists of several related system problems: i.e., individual inadequate composure, inadequate attention, overconfidence in self/others or equipment, lack of confidence, inadequate motivation, haste, pressure, attitude, and effects of alcohol/drugs/illness. Inadequate self-discipline occurred in all of the major problems areas and had the highest frequency of occurrence in each. Some possible underlying reasons for these behavioral lapses area:

a. The pressure experienced by individuals during FTXs tends to create blanks in rapid recall of procedural sequences, or a "jump before thinking" reaction to the exercise situation.

b. Supervisory personnel appear not to be involved in guiding, directing, and correcting their juniors whenever they observe an unsafe behavior or events.

4.2 SYSTEM INADEQUACY: INADEQUATE SUPERVISION BY DIRECT SUPERVISOR

Inadequate supervision by a direct supervisor appears in seven of the major problem areas. Possible underlying causes are:

a. NCOs and Company Officers seem to be inconsistent in their leadership. They may be emphasizing safety during unit proficiency training, but are seemingly taking shortcuts during FTXs.

b. Senior NCOs appear to be passive rather than taking a more active role in providing procedural guidance for less experienced NCOs (Tank/Track and drivers).

4.3 SYSTEM INADEQUACY: INADEQUATE UNIT TRAINING

Inadequate unit training contributed to all nine major problem areas with the most frequent ones being excessive speed or the conditions and inadequate coordination and communication. Possible underlying causes are:

a. Individuals in these accidents demonstrated a low-level of proficiency due to inadequate individual or crew training under controlled conditions, inconsistent training opportunities, or inexperienced trainers at the unit level.

b. Misjudgment of the clearance between a CV and any other hazard, including people, was a problem during the targeted year. This problem is caused by inadequate practice or training drills to develop eye-hand coordination of drivers. Lapses in coordination between Tank/Track Commanders and drivers also contribute to this type of misjudgment.

4.4 SYSTEM INADEQUACY: INADEQUATE EXPERIENCE

The inadequate experience of individuals is related to the system problem of inadequate unit training. It contributed to the accidents in all major problem areas. Possible underlying causes are:

a. CV crews may not be receiving enough practice in procedures as a crew; crews are not being held together as units, and crew turnover can be disruptive because the addition of a new member can mean that the crew must re-learn how each member reacts to varying situations.

b. The study suggested that the feeling of crew responsibility may not be at a high level. The feeling of crew responsibility ensures that CVs are secure, inspected properly, and operated safely.

4.5 SYSTEM INADEQUACY: INADEQUATE WRITTEN PROCEDURES, NORMAL CONDITIONS

Inadequate written procedures contributed to accidents in five of the major problem areas. This system inadequacy is also related to inadequate unit training. Some possible causes are:

a. Unit operations officers might not be consistently updating their Standard Operating Procedures (SOPs). When updates are published, changes may not always be disseminated by company NCOs.

b. Procedural training, based on SOP updates may not be an integral part of unit training.

4.6 SYSTEM INADEQUACY: FATIGUE

Fatigue is a chronic aspect of FTXs because of the operational necessity for high levels of performance from individuals, crews, and organizational elements for extended periods of time. It contributed, at consistently low frequency levels, to accidents in five major problem areas. Some of the possible underlying causes of fatigue are:

a. Work-rest cycles in the field are irregular in length and occurrence. Extreme temperatures, high noise levels and heavy dust caused by maneuvering DVs limit the possibility of uninterrupted sleep. FTX excitement also limits the ability of individuals to rest.

b. Some individuals have not learned how to manage their work-rest opportunities. Guidance from more experienced personnel and unit training can help the individual learn how to recognize and deal with fatigue.

5.0 RECOMMENDATIONS

The actions required at the various Army organizational levels responsible for the conduct of a successful accident prevention program need to be considered. The recommendations below address responsibilities for the Department of the Army (DA), USASC, MACOM, and Army Unit Level Officers and NCOs.

5.1 CHIEF OF STAFF, U.S. ARMY

a. Designate the reduction of CV accidents during FTXs as a goal for the Army worldwide. Establish a timeframe (e.g., 1991) for achievement of this goal by all MACOMs.

b. In compliance with the provisions of Chapter 5: Accident Prevention Awards, of the AR 385-10, establish a special incentive program to recognize field organizations and personnel for their specific contributions to the achievement of the Army goal of safer CV FTX operations.

c. Specify CV operational procedures for FTXs as an item of special interest for the Inspector General at the Department of Army level and below.

5.2 U.S. ARMY SAFETY CENTER

a. Publish an article in COUNTERMEASURE summarizing the results of this study with emphasis on:

   1. The nine major problem areas accounting for accidents in CV FTX operations (i.e., Inadequate Inspection/Testing, Excessive Speed).

   2. The major system inadequacies identified in CV FTX operations (i.e., Inadequate Self-Discipline, Inadequate Supervision, Inadequate Unit Training) were related to 56 percent of the accidents.

   3. Provision of material for presentation as "Lessons Learned" topics in safety classes at all levels of command.

b. Publicize in SOLDIER Magazine, COUNTERMEASURE, and other Army periodicals, the organizations and personnel receiving Safety Awards for CV FTX operations to include any effective techniques, procedures, and practices to prevent CV FTX accidents.

5.3 MAJOR COMMANDS

a. Commit greater high-level staff follow-up of installation safety office recommendations. Monitor the filing of CV accident reports at each intermediate level of command to ensure that field organizations are aware of the commitment of the MACOM to reducing CV FTX accidents.

b. Recognize and reward successful CV accident programs and projects (i.e., FTX with CV accident-free operations) with awards and publicity.

c. Develop programs and commit resources to the overall improvement of CV crew proficiency, safety awareness, and operating procedures in the FTX environment.

d. Concentrate efforts, in all operational theaters, on the orientation and training of newly assigned CV crew personnel to the hazards of the theater FTX environment.

e. Establish and enforce policies supporting the stabilization of CV crew assignments throughout the command as a deterrent to CV FTX accidents caused by poor crew coordination.

5.4 U.S. ARMY TRAINING AND DOCTRINE COMMAND

a. Conduct a review of individual training programs to identify differences in the level of qualification being acquired by all CV drivers as a basis for defining requirements to reduce CV accidents through training programs improvement.

b. Provide the applicable directives, training, and resources required to implement the results of the review of CV driver training to improve the qualifications of drivers and increase the emphasis on safe operation of CV in the FTX environment. Utilize the results of this study to enhance training by incorporating the major problem areas and system inadequacies into the instruction.

5.5 UNIT LEVEL COMMAND

a. Assess unit training programs and identify areas for improvement that will prevent occurrence of major problem areas and related system inadequacies described in this study. Develop and implement the use of training modules that will increase the emphasis on safe operation of CV in the FTX environment.

b. Comply with command policies requiring stable CV crew assignments so that crew members train and operate together on a long-term basis. Emphasize close coordination and communications within each CV.

c. Conduct periodic inspections of unit procedures for CV FTX operations to ensure their adequacy to support CV accident prevention programs as well as operational requirements.

d. Revise unit FTX operating procedures, and conduct procedural training to ensure strict compliance with the requirements for safe operation of CV in field positions with increased emphasis on the proper designation, identification, marking, and use of guides in bivouac/assembly areas.

e. Conduct special training of CV crews prior to FTX operations in the techniques of intra-crew communications and coordination with special attention directed to the interactions of Tank/Track Commander and all other crew members.

f. Exercise command punitive authority against supervisors who allow CV crew to use unsafe procedures under training or operational conditions, and against crew members who operate CV with disregard for safe operating procedures under these conditions.

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